

WHAT IS CLAIMED IS:

1. A drive train for a hybrid vehicle including a driving wheel;
said drive train comprising:

an internal combustion engine having a driving shaft;

an electric motor having a driving shaft connected to the
driving wheel of the vehicle;

an electric generator having a rotor;

a rotational speed increasing gear arrangement having a high
speed portion connected to said rotor of said generator and a low speed
portion;

a switching mechanism connected to said driving shaft of said
internal combustion engine; said switching mechanism being movable between
a first position where it interconnects said driving shaft of said engine to said
low speed portion of said gear arrangement and a second position where it
interconnects said driving shaft of said engine to both said rotor of said
generator and to said driving shaft of said electric motor;

wherein, a) when said switching mechanism is in said first
position, the hybrid vehicle is in a series mode while said generator is operated
at nominal rotation speed while said engine operates at low speed and b) when
said switching mechanism is in said second position, the hybrid vehicle is in a
parallel mode while said generator is operated at a rotation speed of said
engine.

2. A drive train as recited in claim 1, wherein said electric
motor has an internal stator and an external rotor.

3. A drive train as recited in claim 1, wherein said electric
generator has an internal stator and wherein said rotor is external.

4. A drive train as recited in claim 1, wherein:
said driving shaft of said engine defines a rotation axis;
said driving shaft of said electric motor is coaxial with said rotation axis; and
said rotor of said electric generator is coaxial with said rotation axis.

5. A drive train as recited in claim 4, further including a housing in which said electric motor, said electric generator, said rotational speed increasing gear arrangement and said switching mechanism are enclosed.

6. A drive train as recited in claim 5, wherein said rotational speed increasing gear arrangement includes:

a freewheeling gear so mounted to said driving shaft of said internal combustion engine as to rotate about said rotation axis;

a speed increasing gear so mounted to said housing as to rotate about an axis generally parallel to said rotation axis, said speed increasing gear having a smaller gear diameter portion meshed with said freewheeling gear and a larger gear diameter portion meshed with said rotor of said electric generator.

7. A drive train as recited in claim 6, wherein said switching mechanism includes a jaw clutch member mounted to a splined portion of said driving shaft of said engine to be rotated thereby while being axially movable between said first and second positions; said jaw clutch member including first dogs that are connected to dogs of said freewheeling gear when said member is in said first position and second dogs that are simultaneously connected to dogs of said driving shaft of said motor and dogs of said rotor of said generator when said member is in said second position.

8. A drive train for a hybrid vehicle including a driving wheel and an internal combustion engine having a driving shaft; said drive train comprising:

an electric motor having a driving shaft connected to the driving wheel of the vehicle;

an electric generator having a rotor;

a rotational speed increasing gear arrangement having a high speed portion connected to said rotor of said generator and a low speed portion;

a switching mechanism connected to the driving shaft of the internal combustion engine; said switching mechanism being axially movable between a first position where it interconnects the driving shaft of the engine to said low speed portion of said gear arrangement and a second position where it interconnects the driving shaft of the engine to both said rotor of said generator and to said driving shaft of said electric motor;

wherein, a) when said switching mechanism is in said first position, the hybrid vehicle is in a series mode while said generator is operated at nominal rotation speed while the engine operates at low speed and b) when said switching mechanism is in said second position, the hybrid vehicle is in a parallel mode while said generator is operated at the rotation speed of the engine.

9. A drive train as recited in claim 8, wherein said electric motor has an internal stator and an external rotor.

10. A drive train as recited in claim 8, wherein said electric generator has an internal stator and wherein said rotor is external.

11. A drive train as recited in claim 8, wherein:
the driving shaft of the engine defines a rotation axis;
said driving shaft of said electric motor is coaxial with said rotation axis; and
said rotor of said electric generator is coaxial with said rotation axis.

12. A drive train as recited in claim 11, further including a housing in which said electric motor, said electric generator, said rotational speed increasing gear arrangement and said switching mechanism are enclosed.

13. A drive train as recited in claim 12, wherein said rotational speed increasing gear arrangement includes:

a freewheeling gear so mounted to the driving shaft of the internal combustion engine as to rotate about said rotation axis;

a speed increasing gear so mounted to said housing as to rotate about an axis generally parallel to said rotation axis, said speed increasing gear having a smaller gear diameter portion meshed with said freewheeling gear and a larger gear diameter portion meshed with said rotor of said electric generator.

14. A drive train as recited in claim 13, wherein said switching mechanism includes a jaw clutch member mounted to a splined portion of the driving shaft of the engine to be rotated thereby while being axially movable between said first and second positions; said jaw clutch member including first dogs that are connected to dogs of said freewheeling gear when said member is in said first position and second dogs that are simultaneously connected to dogs of said driving shaft of said motor and dogs of said rotor of said generator when said member is in said second position.

15. A method for controlling the drive train of a hybrid vehicle including an electric motor, an electric generator, an internal combustion engine and a driven wheel comprising the acts of:

providing a rotational speed increasing gear arrangement having a high speed portion connected to a rotor of the electric generator and a low speed portion;

providing a switching mechanism connected to a driving shaft of the internal combustion engine; the switching mechanism being axially movable between a first position where it interconnects the driving shaft of the engine to the low speed portion of the gear arrangement and a second position where it interconnects the driving shaft of the engine to both a rotor of the generator and to a driving shaft of the electric motor;

when a low speed serial hybrid mode is desired, placing the switching mechanism in the first position and operating the internal combustion engine at a predetermined low speed;

when a high speed parallel hybrid mode is desired, placing the switching mechanism in the second position and operating the internal combustion engine as determined by an input control.